BANK OF CANADA
BANQUE DU CANADA

Discussion Paper/Document d'analyse
2012-1

A Foreign Activity Measure for Predicting Canadian Exports

by Louis Morel

www.bank-banque-canada.ca

Bank of Canada Discussion Paper 2012-1

February 2012

A Foreign Activity Measure for Predicting Canadian Exports

by

Louis Morel

Canadian Economic Analysis Department
Bank of Canada
Ottawa, Ontario, Canada K1A 0G9
lmorel@bankofcanada.ca

Bank of Canada discussion papers are completed research studies on a wide variety of technical subjects relevant to central bank policy. The views expressed in this paper are those of the author. No responsibility for them should be attributed to the Bank of Canada.

ISSN 1914-0568

© 2012 Bank of Canada

Acknowledgements

The author would like to acknowledge Jean Boivin for his guidance and technical advice. This paper has also benefited from many discussions with Marc-André Gosselin, Nicolas Parent, Jean-François Perrault, Don Coletti, Sharon Kozicki and Stephen Murchison, as well as comments received from a seminar held at the Bank of Canada.

Abstract

The author constructs a measure of foreign activity that takes into account the composition of foreign demand for Canadian exports. It has a number of interesting features. First, the foreign activity measure captures both the composition of demand in the United States (by including components of U.S. private final domestic demand) and economic activity outside of the United States. Second, its coefficients have been estimated over the sample period 1981–2009 controlling for the effect of changes in relative prices. Third, compared with the Bank's previous U.S. activity index (introduced in the July 2009 *Monetary Policy Report*), the foreign activity measure provides some improvements for forecasting Canadian exports, especially at longer horizons. For instance, at eight quarters ahead, the gain in terms of forecast accuracy is as much as 22 per cent. Finally, the foreign activity measure helps to explain why Canadian exports dropped by 20 per cent during the global recession of 2008–09 and have only partially recovered since that time.

JEL classification: E00, F17
Bank classification: Balance of payments and components; Exchange rates; Recent economic and financial developments

Résumé

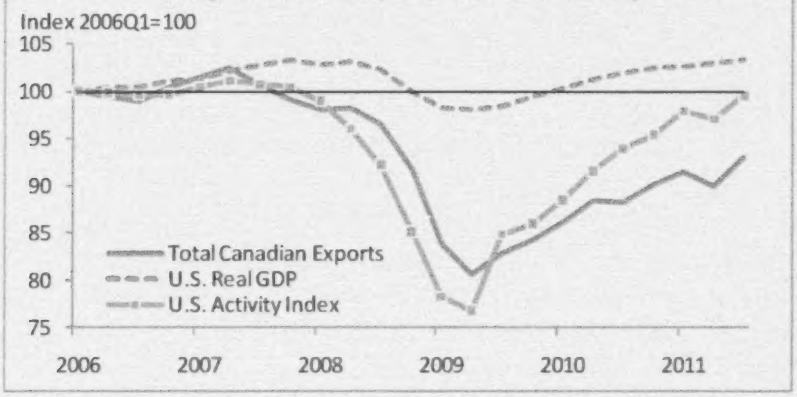
L'auteur construit une mesure de l'activité économique étrangère qui traduit la composition de la demande d'exportations canadiennes. Cette mesure présente certaines caractéristiques intéressantes. Premièrement, elle reflète à la fois la composition de la demande aux États-Unis (puisqu'elle intègre des composantes de la demande intérieure finale privée dans ce pays) et l'activité économique dans le reste du monde. Deuxièmement, l'estimation de ses coefficients sur la période 1981-2009 tient compte de l'effet des modifications des prix relatifs. Troisièmement, la mesure en question permet de mieux prévoir les exportations canadiennes, surtout aux horizons éloignés, que l'indice précédent de l'activité aux États-Unis (décrit dans le *Rapport sur la politique monétaire* de juillet 2009). À l'horizon de huit trimestres, par exemple, le gain de précision atteint jusqu'à 22 %. Enfin, la mesure de l'activité étrangère aide à expliquer pourquoi les exportations canadiennes ont chuté de 20 % durant la récession mondiale de 2008-2009 et pourquoi elles ne se sont que partiellement redressées depuis.

Classification JEL : E00, F17
Classification de la Banque : Balance des paiements et composantes; Taux de change; Évolution économique et financière récente

1 Introduction

The importance of taking into consideration the composition of foreign demand to explain the behaviour of Canadian exports became clearer than ever during the most recent global recession. From early 2008 to mid-2009, the level of Canadian exports dropped by about 20 per cent (Figure 1). During this period, U.S. GDP fell by significantly less (-5.1 per cent), suggesting that the composition of foreign demand was much less favourable than indicated by U.S. GDP. In fact, the behaviour of exports seemed to be more in line with the Bank of Canada's U.S. activity index, which captures activity in those sectors that matter most for Canadian exporters.[1] For instance, given the collapse in U.S. sales of motor vehicles, Canadian exports of automotive products (which typically account for about 20 per cent of overall exports) took an important hit, with a drop of over 50 per cent during this period. The U.S. activity index captured such a drop since it accounts for differences in import propensities across demand components, as well as changes in their contribution to GDP over time.

Figure 1. The recent experience shows the importance of foreign demand composition for Canadian exports



This paper builds on the previous analysis that led to the construction of the U.S. activity index and proposes a new measure of foreign activity. The new measure has a number of interesting features:

- In assessing the demand for Canadian exports, the foreign activity measure takes into account both the composition of demand in the United States (by including components of the U.S. private final domestic demand) and economic activity outside of the United States.
- Its coefficients have been econometrically estimated over the sample period 1981–2009 controlling for the effect of changes in relative prices.
- Compared with the Bank's previous U.S. activity index, the foreign activity measure provides some improvements for forecasting Canadian exports, especially at longer

[1] This index was first introduced to Canadians in the Bank of Canada's July 2009 *Monetary Policy Report* (Technical Box 2). See the appendix for a description of this index.

horizons. For instance, at eight quarters ahead, the accuracy gain obtained when forecasting non-commodity exports is as much as 22 per cent. It also avoids any double counting issues that were present in the previous index.

The paper is organized as follows. The next section presents a general framework for predicting Canadian exports. In section 3, we estimate our foreign activity measure; its forecast performance is evaluated in section 4. Section 5 concludes.

2 Framework for Predicting Canadian Real Exports

In a general framework, real exports are modelled as a function of foreign demand or income and relative prices (including exchange rate variations). For instance, in ToTEM (Murchison and Rennison 2006), the Bank's quarterly projection model for the Canadian economy, the derived-demand function for non-commodity exports is[2]

$$x_{nc,t} = -\vartheta p^*_{m,t} + y^*_t + e_t, \tag{1}$$

where x_{nc} represents non-commodity exports, p^*_m is the real foreign-currency price of Canada's non-commodity exports, and y^* denotes foreign output, all in logs. The coefficient ϑ is the elasticity of substitution between domestic non-commodity exports and similar, foreign-produced goods (calibrated to 1.2). Relative prices are allowed to take time to adjust to exchange rate variations (Calvo-type rigidities), and unit elasticity is imposed on foreign demand.[3]

It is common practice to proxy foreign demand (y^*) using a trade-weighted measure of foreign output, in which the weight on GDP of each country is determined based on historical trade patterns (for instance, given the importance of the United States as a destination for Canadian exports, this country would have a weight of almost 82 per cent in y^*). While such a foreign-output measure is simple to understand and calculate, it does not account for the composition of demand within countries. Thus, it may not reflect activity in the key sectors of the world economy that matter for Canadian exports. For instance, the import intensities of U.S. consumption and investment are different and their contribution to output fluctuates.[4] Looking

---

[2] Equation (2.58) in Murchison and Rennison (2006). ToTEM differentiates between commodity and non-commodity exports (non-commodity exports represented about 80 per cent of total exports in Canada, on average, over the past 10 years). Commodity exports are determined by the interaction between world commodity prices and the marginal cost of producing an extra unit of the commodity. Given the profit-maximization behaviour of commodity-producing firms in an environment of perfect competition, these firms produce up to the point at which their marginal cost equals the world price for commodities, expressed in a common currency.

[3] In Murchison and Rennison (2006), an additional term ($\vartheta_2 \widetilde{Y^*_t}$) is included in equation (1), where $\widetilde{Y^*_t}$ is the rest-of-world output gap. This additional term captures a short-term elasticity of exports to foreign demand that is greater than one in the data. This term is ignored in our analysis, since the focus is on the long-term behaviour of Canadian exports (cointegrating relationship). The export residual e_t in equation (1) is assumed to follow an AR(1) process, with a root of 0.8 (historical persistence).

[4] For instance, Buissière et al. (2011, Table 1a) show that the import content of U.S. consumption in 2005 was about 12 per cent, while that of U.S. investment was around 17 per cent.

just at changes in U.S. GDP would fail to account for this fact. The new measure of foreign activity is being developed to address such issues and will be used to replace y^* in equation (1).

3 Constructing a Foreign Activity Measure

3.1 The set-up

To illustrate the intuition behind the construction of a foreign activity measure, consider a simple example with one foreign country and two sectors of activity. The question is: how should activity in these two sectors be aggregated to be most effective in a forecasting model for Canadian exports? The approach taken is to express Canadian exports as a function of a constant, demand from these two sectors (a_1 and a_2) and their respective relative prices (pa_1^* and pa_2^* are the foreign prices of Canadian exports relative to prices of foreign output in sectors a_1 and a_2, respectively):

$$x_t = c - \left(\lambda_1 pa_{1,t}^* + \lambda_2 pa_{2,t}^*\right) + \left(\gamma_1 a_{1,t} + \gamma_2 a_{2,t}\right) + e_t \,. \tag{2}$$

The foreign activity measure $\hat{A}_t$, which is the estimated demand for Canadian exports, is given by

$$\hat{A}_t = \left(\hat{\gamma}_1 a_{1,t} + \hat{\gamma}_2 a_{2,t}\right). \tag{3}$$

The coefficient $\hat{\gamma}_1$ in equation (3) can be interpreted as the estimated sensitivity of exports to a change in a_1 after controlling for demand in the other sector and relative prices. The estimated foreign activity measure $\hat{A}_t$ is therefore not simply a fitted value of Canadian non-commodity exports projected on foreign demand; it also accounts for the endogeneity of exports with respect to relative prices. It is also important to note that the coefficients in equation (3) are elasticities estimated on historical data. The foreign activity measure is normalized based on an assumption that the long-run activity elasticity (income elasticity) of exports is unity.

This simple example could easily be expanded to include many sectors and many countries, say a total of I components a_i:

$$x_t = c - \sum_{i=1}^{I} \lambda_i pa_{i,t} + \sum_{i=1}^{I} \gamma_i a_{i,t} + e_t \,. \tag{4}$$

In this case, the estimated foreign activity measure would be given by

$$\hat{A}_t = \sum_{i=1}^{I} \hat{\gamma}_i a_{i,t} \,. \tag{5}$$

3.2 The estimation exercise

To estimate the foreign activity measure, rewrite equation (1) with the foreign activity measure A_t replacing y_t^* and $\sum_{i=1}^{I} \gamma_i p_{m,i,t}^*$ replacing $p_{m,t}^*$. Here, $p_{m,i}^*$ is the foreign relative price associated with the i^{th} activity component:

$$x_{nc,t} = c - \vartheta \sum_{i=1}^{I} \gamma_i p_{m,i,t}^* + \sum_{i=1}^{I} \gamma_i a_{i,t} + \beta_1 open_t + e_t . \quad (6)$$

In addition, the variable *open*, which is defined as the ratio of exports to GDP among all OECD countries, is included in equation (6) to proxy for the overall increase in trade liberalization through time, which may not be fully captured by the relative price of exports used in equation (6).[5] All variables in equation (6) are expressed in log-level terms. Several of the variables in this expression are integrated of order 1, so estimation of this expression corresponds to estimation of a cointegrating relationship if residuals are stationary.

Several assumptions are made during estimation of the foreign activity measure. The coefficients γ_i are assumed to be time-invariant.[6] The foreign activity measure is assumed to be exogenous to Canadian exports. This assumption is justified from the observation that Canada is a small open economy and, thus, that what happens in the rest of the world should affect Canada, but not the opposite. Trade openness is also assumed to be exogenous to Canadian exports in our specification. Relative prices, however, are assumed to be endogenously determined; to control for this endogeneity problem, we estimate equation (6) using dynamic ordinary least squares (i.e., adding lags and leads of the first differences of relative prices).

Several factors influenced the selection of the components, a_i, to be used to construct the foreign activity measure. To capture the composition of demand in the United States, only components of U.S. final domestic demand were considered. This decision was motivated by the intuition that, except for re-exported products, components of U.S. final domestic demand are the source of the demand for everything that is exported by Canadian firms to the United States. Disaggregating foreign output is important since the import intensities of the components of GDP are different and their contribution to output fluctuates. To capture sources of demand outside of the United States (including U.S. re-exports), a measure of trade-weighted foreign GDP excluding the United States was considered. While a final domestic demand aggregate from outside the United States would have been preferable, such an option was not feasible given the limited availability of historical domestic demand data for some countries, such as China.

---

[5] The inclusion of the variable *open* brings the unrestricted sum of the coefficients on the components of the foreign activity variable closer to unity, which is a necessary condition for balanced growth in ToTEM. While there is an upward trend in exports relative to foreign output over the sample, the unit income elasticity is not rejected by the data in the presence of a proxy to capture increasing openness to trade. Note also that, although the coefficients of the foreign activity measure will be estimated using non-commodity exports, section 4 also describes the out-of-sample forecasting performance of this indicator for overall exports.

[6] One alternative to the approach taken in this paper would be to allow elasticities to slowly evolve over time.

Several specifications were estimated. The most aggregated breakdown of U.S. final domestic demand is: U.S. consumption expenditures, U.S. residential investment, U.S. business investment and U.S. government expenditures. In all specifications considered, U.S. government expenditures were found not to matter (statistically) for Canadian exports. This result may reflect the fact that the largest government expenditures usually comprise employee compensation and the purchase of services, which are both non-traded. For this reason, only components of U.S. private final domestic demand were included in the preferred foreign activity measure. Additional disaggregations were also evaluated – such as a decomposition of consumption into motor vehicle consumption and other consumption expenditures, as well as a split of business investment into investment in machinery and equipment and investment in non-residential structures. However, forecast accuracy (discussed in section 4) generally deteriorated slightly with disaggregated consumption and/or business investment.[7]

The estimation of equation (6) was performed on non-commodity export data from 1981Q1 to 2009Q3.[8] The relative-price measures linked to the demand components were constructed using U.S. National Income and Product Account deflators (consumption, residential and business investment) and foreign consumer price indexes (outside of the United States – weighted by Canadian export shares). The foreign activity measure was constructed using equation (5) with the estimated coefficients $\widehat{\gamma_i}$ (constant over this entire sample).

3.3 The foreign activity measure

The foreign activity measure was chosen, from candidate measures based on a variety of combinations of foreign variables, to be the one that minimized the root mean squared errors (RMSEs) in a forecast evaluation described in section 4.[9] Table 1 shows the components of the foreign activity measure and their estimated unrestricted coefficients. From a pure forecasting perspective, there is no need for restricting the sum of the coefficients on the components of the foreign activity measure to be one. Given, however, that the intent is to use the foreign

---

[7] Although in-sample structural break tests suggested imposing a structural break in 1994Q2 (possibly linked to the ratification of the North American Free Trade Agreement), imposing a break in 1994Q2 to our preferred specification generated larger forecast errors, on average, in an out-of-sample forecasting exercise.

[8] A time series of non-commodity exports was computed based on observed data. However, disaggregated export data (in volumes) are only available since 1997 via Statistics Canada's balance of payments. To expand the data back to 1981 required a backward extension of the fitted values obtained from regressing over 1997 to 2009 the non-commodity export series constructed from the balance-of-payments data on disaggregated export data from the national accounts (this regression's adjusted R^2 is 0.96). The specific national account export data used were agricultural and fish products, energy products and industrial goods and materials. The estimated shares of commodity products within these export categories are, respectively, 80.9 per cent, 87.1 per cent and 13.9 per cent.

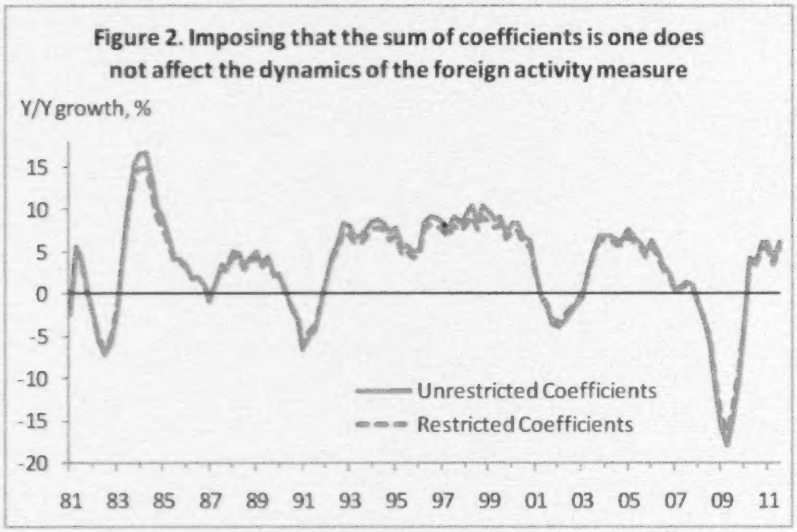
[9] The combinations considered were: CHIY*, CHiY*, cHIY*, cHiY*, CHIXY* and the same five combinations with a break in the parameters in 1994Q2. C stands for U.S. consumption, c: both U.S. consumption of autos and U.S. consumption ex-autos, H: U.S. residential investment, I: U.S. business investment, i: both U.S. business investment in structures and U.S. investment in machinery and equipment, X: U.S. exports, Y*: foreign GDP outside the United States.

activity measure in the Bank of Canada's quarterly projection model (ToTEM), the unit sum of coefficients ensures that the steady-state growth of Canadian exports equals that of the individual components of the foreign economic activity measure (U.S. consumption, etc.), a necessary condition in the model in order to generate a balanced growth path. A statistical test also reveals that the sum of the unrestricted estimated coefficient is not statistically different from one. Moreover, as shown in Figure 2, restricting the sum of the coefficients to unity does not alter considerably the dynamics of the foreign activity measure. The restriction is therefore imposed; the restricted coefficients are shown in Table 1. Finally, tests of the null hypothesis of cointegration in equation (6) were not rejected at a 10 per cent significance level, consistent with a stable long-run relationship between the proposed measure of foreign activity, Canadian (non-commodity) exports and relative prices.

Table 1. The composition of the foreign activity measure

Components	Unrestricted coefficients	Restricted coefficients
U.S. consumption	0.248	0.207
U.S. residential investment	0.182	0.175
U.S. business investment	0.560	0.486
Foreign GDP outside of the United States	0.108	0.132

Figure 2. Imposing that the sum of coefficients is one does not affect the dynamics of the foreign activity measure

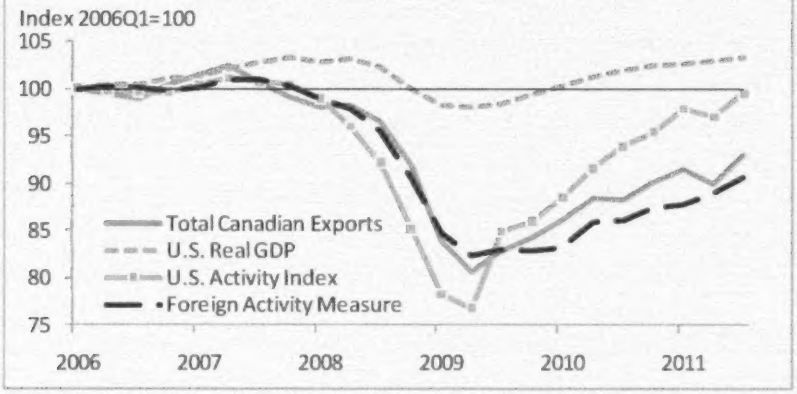


Because equation (6) was estimated using series expressed in logarithm, these coefficients represent elasticities. For instance, a 10 per cent increase in U.S. consumption will, *ceteris paribus*, generate a 2.1 per cent increase in the foreign activity measure (as well as in Canadian exports, since the income elasticity of exports is one). It is particularly important to emphasize the *ceteris paribus* condition here. In practice, an increase in U.S. consumption is often observed in conjunction with an increase in U.S. residential/business investment, since these

variables all behave in a procyclical manner.[10] In that respect, the estimated elasticities are reduced-form coefficients and should not be given any structural interpretation. The relative magnitude of the coefficients approximates the import propensities of the components of foreign demand.

As noted in the introduction, the composition of foreign demand matters to explain Canadian exports. This is especially true for the 2008–09 period, over which exports dropped by about 20 per cent. Figure 3 shows that the foreign activity measure also explains well the large decline in foreign demand for Canadian exports over this period. Moreover, it maps better than the U.S. activity index the increase in exports observed between 2009Q2 and 2011Q3.

Figure 3. The foreign activity measure also explains well the drop in Canadian exports over 2008-2009



4 Forecast Evaluation

This section evaluates whether the foreign activity measure estimated in section 3 is a good out-of-sample predictor of Canadian (non-commodity) exports.

4.1 The set-up

Since the main goal of this project is to develop a foreign activity measure to improve the forecast of Canadian exports, an out-of-sample forecasting exercise is set up to approximate the current projection environment in place at the Bank. The ultimate test for the foreign activity measure would be to collect real-time forecasts of the components of the two activity measures and compare the out-of-sample forecasting performance of the real-time estimates of the new measure relative to the real-time estimates of the Bank's U.S. activity index. This

[10] This point is evident in a variance decomposition of the foreign activity measure. Because this measure is the sum of four components, the variance of the sum is equal to the sum of the variances plus two times the six covariances. The historical data over the sample period 1981–2009 show that the sum of the four variances explains only about 40 per cent of the variance of the foreign activity measure, while the covariance terms explain the remaining 60 per cent.

exercise is not possible, however, since not all components were forecasted in real time. One alternative would be to take the current version of the Bank models of these components and simulate them over history using real-time data to construct quasi-real-time forecasts. Such an exercise is unquestionably very ambitious and technically challenging. Instead, a simple yet interesting exercise is proposed.

As in the projection exercise undertaken every quarter at the Bank of Canada, in order to forecast Canadian exports, a forecast of foreign demand must first be obtained. To do so for this exercise, for both the U.S. activity index and the foreign activity measure, a vector autoregressive (VAR) model is set up with three lags to forecast the components of the two foreign demand measures:[11]

$$\begin{pmatrix} a_{1,t} \\ a_{2,t} \\ \vdots \\ a_{I,t} \end{pmatrix} = \mathrm{C}_1 \begin{pmatrix} a_{1,t-1} \\ a_{2,t-1} \\ \vdots \\ a_{I,t-1} \end{pmatrix} + \mathrm{C}_2 \begin{pmatrix} a_{1,t-2} \\ a_{2,t-2} \\ \vdots \\ a_{I,t-2} \end{pmatrix} + \mathrm{C}_3 \begin{pmatrix} a_{1,t-3} \\ a_{2,t-3} \\ \vdots \\ a_{I,t-3} \end{pmatrix} + \epsilon_t, \tag{7}$$

where C_1, C_2 and C_3 are IxI lag-coefficient matrices. Then, in equation (8), a forecast of each aggregate activity measure is reconstructed based on the forecasted components (at any horizon) and the coefficients $\widehat{\gamma}_i$ estimated over the whole sample (from Table 1):

$$A_t = \sum_{i=1}^{I} \widehat{\gamma}_i a_{i,t} \,. \tag{8}$$

The coefficients $\widehat{\gamma}_i$ are held constant during the whole exercise. A forecast of the U.S. activity index is similarly reconstructed using the weights shown in the appendix. Building on equation (6), non-commodity exports and relative foreign prices are regressed on non-commodity exports, relative foreign prices and foreign demand using the following system of equations:

$$\begin{pmatrix} x_{nc,t} \\ p^*_{m,t} \end{pmatrix} = \mathrm{B}_1 \begin{pmatrix} x_{nc,t-1} \\ p^*_{m,t-1} \end{pmatrix} + \mathrm{B}_2 \begin{pmatrix} x_{nc,t-2} \\ p^*_{m,t-2} \end{pmatrix} + \mathrm{B}_3 \begin{pmatrix} x_{nc,t-3} \\ p^*_{m,t-3} \end{pmatrix} + \delta_0 A_t + \delta_1 A_{t-1} + \delta_2 A_{t-2} + \mu_t, \tag{9}$$

where B_1, B_2 and B_3 are 2x2 lag-coefficient matrices, and δ_0, δ_1 and δ_2 are 2x1 matrices. This set-up is similar to a VAR(3) in level terms between non-commodity exports, relative foreign prices (constant across activity variables) and a measure of foreign activity, although the activity variable is restricted to be exogenously determined and not affected by the lags of the other two variables.[12]

For each of the two candidates, equations (7), (8) and (9) are estimated over the sample period 1981Q1–1999Q4. Values for $x_{nc,t+h}$ are then forecast at horizons $h = 1, 2, 4, 8$. The forecasted

[11] The lag structure in equations (7), (8) and (9) was selected using Akaike's information criterion.

[12] As noted in section 3.2, the assumption that the foreign activity variable is exogenous reflects the fact that Canada is a small open economy.

level of non-commodity exports at horizon h is compared with its realization at period $t + h$.[13] The estimation window is expanded by one observation (1981Q1–2000Q1) and forecasted values are once again obtained. This exercise is repeated until 2009Q3. RMSEs are computed over the sample period 2000Q1–2009Q3 for the four forecast horizons considered.

The main advantage of this pseudo out-of-sample forecasting exercise is that it not only takes into account the uncertainty associated with forecasting non-commodity exports, but it also takes into consideration the uncertainty of forecasting each component of the activity measure.

4.2 Forecast evaluation results

Table 2 reports the results of the out-of-sample forecasting exercise. More specifically, it shows the RMSEs obtained by forecasting non-commodity exports using both the U.S. activity index and the foreign activity measure, for the four horizons considered. These RMSEs are shown in absolute terms in the first half of the table, and relative to the U.S. activity index in the bottom half. At all horizons considered, the foreign activity measure provides forecast accuracy gains over the U.S. activity index. These gains range from 10 per cent one quarter ahead to 22 per cent eight quarters ahead. All these differences are statistically significant at 5 per cent using a Diebold-Mariano test.

Table 2. RMSEs obtained by forecasting non-commodity exports (2000–09)

Activity measures	Forecast horizon (quarters)			
	1	2	4	8
In absolute terms				
U.S. activity index	0.039	0.052	0.089	0.212
Foreign activity measure	0.035	0.046	0.075	0.166
Relative to the U.S. activity index				
U.S. activity index	1.00	1.00	1.00	1.00
Foreign activity measure	0.90	0.88	0.84	0.78

Because of the way Canadian exports are modelled at the Bank, the estimation and the forecast evaluation performed to this point have been on non-commodity exports. An interesting question is whether the foreign activity measure developed for non-commodity exports is useful for forecasting total exports. Table 3 reports the results of a forecast evaluation that substitutes total exports for non-commodity exports in equation (9) (the foreign activity variables remain the same). These results show that, even for total exports, the forecast accuracy gains could be large, especially at longer horizons (a 41 per cent improvement eight quarters ahead). The Diebold-Mariano predictive-accuracy test results show that these improvements are statistically significant.

[13] Note that this exercise does not use real-time data.

Table 3. RMSEs obtained by forecasting total exports (2000–09)

Activity measures	Forecast horizon (quarters)			
	1	2	4	8
In absolute terms				
U.S. activity index	0.034	0.047	0.072	0.158
Foreign activity measure	0.029	0.037	0.053	0.092
Relative to the U.S. activity index				
U.S. activity index	1.00	1.00	1.00	1.00
Foreign activity measure	0.83	0.80	0.73	0.59

5 Conclusion

In this paper, a measure of foreign activity was constructed for use in predicting Canadian exports. This measure captures the composition of foreign demand for Canadian exports by including U.S. private final domestic demand components and economic activity outside of the United States. Also, its coefficients have been estimated by controlling for the effect of changes in relative prices. This measure improves the forecast accuracy of exports over the Bank's previous U.S. activity index, especially at longer horizons. For instance, at eight quarters ahead, the gain obtained when forecasting non-commodity exports is as much as 22 per cent.

The foreign activity measure has other interesting features. First, it captures the collapse in Canadian exports observed over 2008–09 as well as the U.S. activity index does, and seems to capture better the partial rebound of exports observed since mid-2009. Second, given that this measure contains only four components, and that these components are all mutually exclusive macroeconomic variables, the links between changes in foreign demand and changes in Canadian exports are more transparent.

References

Buissière, M., G. Callegari, F. Ghironi, G. Sestieri and N. Yamano. 2011. "Estimating Trade Elasticities: Demand Composition and the Trade Collapse of 2008-09." National Bureau of Economic Research Working Paper No. 17712.

Dion, R., M. Laurence and Y. Zheng. 2005. "Exports, Imports, and the Appreciation of the Canadian Dollar." *Bank of Canada Review* (Autumn): 5–17.

Murchison, S. and A. Rennison. 2006. "ToTEM: The Bank of Canada's New Quarterly Projection Model." Bank of Canada Technical Report No. 97.

Appendix. The Bank of Canada's Previous U.S. Activity Index

Introduced in the July 2009 *Monetary Policy Report*, the Bank of Canada's previous U.S. activity index was first developed internally in 2003 and used in the short-run forecasting of Canadian exports (the current and next quarter's forecast) via a model similar to the one proposed in Dion, Laurence and Zheng (2005). This index is a weighted average of seven U.S. variables (Table A1), each variable representing the most plausible candidate to proxy U.S. activity relevant for the seven broad categories of Canadian exports. For instance, the construction of this index supposes that machinery and equipment (M&E) exports from Canada will be absorbed into U.S. investment of machinery and equipment. Given that M&E exports represent about 24 per cent of overall Canadian exports, a weight of 24 per cent is given to U.S. M&E investment in this index of U.S. activity. The weights in Table A1 have been calibrated based on Canadian historical export shares.

Table A1. The composition of the U.S. activity index previously used at the Bank of Canada*

Canadian export categories	U.S. activity variables within the index	Weight (%)
Forestry products	Residential construction	3.8
Other intermediate goods	Industrial production	34.5
Motor vehicle parts	Motor vehicle production	6.4
Motor vehicles	Motor vehicle sales	14.6
Machinery and equipment	Investment in machinery and equipment	23.5
Consumer goods	Personal consumption in goods	4.0
Services	U.S. GDP	13.0

* All variables are in real terms. The aggregation is done by averaging the quarterly growth rate of each variable (not annualized).